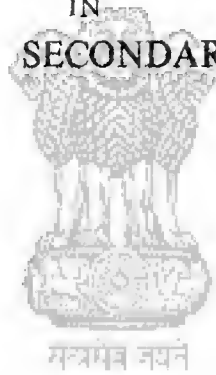




REPORT
ON
SCIENCE LABORATORIES AND EQUIPMENT
IN
HIGH/HIGHER SECONDARY SCHOOLS

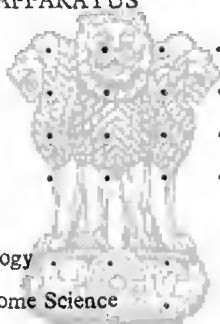


COMMITTEE ON PLAN PROJECTS
GOVERNMENT OF INDIA
NEW DELHI

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CHAPTER I

INTRODUCTORY

1. *Introduction :*

1.1. At the instance of Delhi Administration a Panel for Delhi Higher Secondary School Buildings was set up by the Committee on Plan Projects in June, 1960. The Panel studied in detail the building requirements of higher secondary schools as suggested by the Education Department, Delhi, keeping in view particularly the specific needs of the comprehensive syllabus prescribed by the Board of Higher Secondary Education. The Government school buildings constructed heretofore were meant for high school classes where the syllabus was not as extensive and the existing buildings could not, therefore, meet the needs of the higher secondary syllabus. Besides working out the details of the instructional, administrative and ancillary accommodation required in a higher secondary school, the Panel made a study of the needs of laboratories and their furniture and fittings, keeping in view the special needs of the higher secondary syllabus.

1.2. The Report on Delhi School Buildings embodying these recommendations was circulated to the State Governments who evinced great interest in the norms laid down in the report. The Government of Mysore held a Seminar on School Buildings. At their request the Committee on Plan Projects deputed two of their representatives to participate in the deliberations. The norms laid down by this Panel were accepted at this Seminar. Bihar Government also set up a "Committee for Secondary School Buildings" to examine the question of construction of buildings and laboratories for high/higher secondary schools/multipurpose schools specially with a view to reducing construction cost while ensuring adequate accommodation.

1.3. Since the scope of study of this Panel was restricted to the special requirements of higher secondary schools in Delhi, it was felt desirable to make a more comprehensive and extensive study to lay down norms and standards for science laboratories and equipment for high/higher secondary schools at an all-India level. This was considered all the more necessary since the number of higher secondary schools by the end of the Third Plan is expected to rise to 6,390 from 3,121 at the end of the Second Plan. The Third Plan also gives special importance to science education. In addition to providing general science in all the secondary schools as a compulsory subject more than 9,500 out of 21,800 secondary schools are to have science as an elective subject.

1.4. Accordingly, a broad-based and composite Panel for Science Laboratories and Equipment was set up under the Chairmanship of Dr. K. N. Mathur, Director, Central Scientific Instruments Organisation of the Council of Scientific and Industrial Research. The composition and terms of reference of the Panel are given below:

1. Dr. K. N. Mathur, Director, Central Scientific Instruments Organisation, Council of Scientific & Industrial Research, New Delhi—*Chairman*.

2. Shri S. K. Sen, Deputy Director, Indian Standards Institution New Delhi—*Member*.
3. Smt. S. Doraiswami, Deputy Director, Directorate of Extension Programmes for Secondary Education, New Delhi—*Member*.
4. Shri M. H. Pandya, Architect, Central Building Research Institute, Roorkee—*Member*.
5. Shri G. S. Baderia, Deputy Inspector of Schools, Directorate of Education, Delhi—*Member*.
- *6. Shri G. S. Barotia, Principal, Government Boys Higher Secondary School, Andha Mughal, Delhi—*Member*.
7. Shri T. P. Singh, Principal, Government Higher Secondary School, Jangpura, New Delhi—*Member*.
8. Shri B. K. Ishrish, Senior Chemistry Teacher, Government Higher Secondary School, Rajendra Nagar, New Delhi—*Member*.
9. Shri Jagdish Singh, Member-Secretary, Education Team, Committee on Plan Projects, New Delhi.. *Member-Secretary*.

Terms of Reference :

- (i) To fix norms and to suggest standard lay-outs for science laboratories for Physics, Chemistry, Biology and Home Science in High/Higher Secondary Schools.
- (ii) To suggest standard sets of equipment and apparatus both for practical work and demonstration for the various laboratories.
- (iii) To lay down specifications and standards for equipment and apparatus and suggest procedure for quality control.
- (iv) To suggest simplification of procedure for allotment of funds and procurement of equipment etc.
- (v) To examine the possibilities of having a centralised agency for the manufacture and procurement of science equipment.
- (vi) To consider the possibilities for simplification of methods of work in the laboratories.

1.5. The Panel was constituted in May 1961. At its first meeting held on 26th July 1961, two separate Sub-Committees for detailed study were constituted. Sub-Committee I, as per composition given below, was entrusted with item (i) of the Terms of Reference :—

1. Shri M. H. Pandya—*Convener*.
2. Shri T. P. Singh—*Member*.
3. Shri M. D. Paul Manickam, Executive Engineer, Buildings Projects Team, Committee on Plan Projects—*Co-opted Member*.
4. Shri B. L. Chadha, Consulting Architect, New Delhi—*Co-opted Member*.

*Shri Barotia replaced Shri Rajendra Prasad, Principal, Ram Roop Vidya Mandir, nominated by the Director of Education earlier.

Sub-Committee II, with the following composition, was given detailed study of the items (ii) and (iii) of the Terms of Reference :

1. Shri S. K. Sen —*Convener*.
2. Shri G. S. Baderia—*Member*.
3. Shri T. P. Singh —*Member*.
4. Shri G. S. Barotia—*Member*.
5. Shri B. K. Ishrish—*Member*.
6. Mrs. I. Muliyl, Dy. Inspectress of Schools (Domestic Science), Directorate of Education, Delhi—*Co-opted Member*.

The Sub-Committees were further authorised to co-opt experts in the field, if considered necessary.

1.6. The Panel places on record its appreciation of the work done by the Conveners and Members of the two Sub-committees in making a very thorough and detailed study of the items entrusted to them. The Sub-committees were assisted by several school teachers and Principals of some of the schools in Delhi, whose willing co-operation facilitated the work considerably. The officers of the Directorate of Education and the Board of Higher Secondary Education, Delhi, gave their support and guidance most ungrudgingly. The Panel wishes to record its appreciation of the hard and painstaking work done by the Member-Secretary, Shri Jagdish Singh and his staff without whose earnest and sustained work this Report would not have been possible.

2. The Nature of the Problem :

2.1. Rapid industrialisation of India has created an unprecedented demand for trained scientific personnel. To meet this demand, more and more emphasis is being given to the teaching of science at all levels. It is also being realised that in order to improve science teaching at the level of Universities, it is essential that the base at the school level is suitably strengthened. In this context the Ministry of Education and the University Grants Commission have been seized with the problem of improving school science and various schemes are under their active consideration for improving the standard of science teaching.

2.2. While some thought has been given to the planning of school buildings, the special requirements of teaching science have not been given the attention that the subject demands. The Panel has, therefore, given considerable thought to the planning of laboratories in order to evolve an overall plan which could be applied to all new laboratories to be constructed.

2.3. A number of higher secondary schools in Delhi, Roorkee and Dehra Dun were visited with a view to have a comparative idea of the existing situation with regard to the provision of facilities for teaching of science. The Panel found that while a few schools had reasonably well-equipped laboratories for the science subjects, the condition in others was far from satisfactory. The laboratories were over-crowded and lacked equipment and furniture. The enrolment for the subjects was beyond the capacity of the laboratories. In their visits to various laboratories, the Panel noted specially that many of the laboratories were badly lit. The ventilation in Chemistry

laboratories was particularly very poor with the result that the rooms were full of fumes when the students were working. The furniture in most cases was ill-designed and the services were badly laid.

2.4. In the following paragraphs the Panel has made detailed recommendations in respect of planning of accommodation, services and the arrangement of work-tables in the laboratories. The detailed lay-outs of laboratories are appended. (Appendix II).

2.5. The Panel further made an exhaustive study of the various items of apparatus and equipment that each science laboratory in a high/higher secondary school should have. In making its recommendations on the subject, due weight had to be given to the availability of funds. Accordingly items of apparatus have been separately categorised as 'essential', 'desirable' and 'supplementary', as explained in detail in Chapter III of the Report. Detailed lists drawn up by the Panel for each science subject are appended (Appendix I).

2.6. In making the recommendations in this report, the Panel has kept in view primarily the syllabus prescribed by the Central Board of Secondary Education, Delhi. These recommendations could, however, be applied to high/higher secondary schools in other States as well subject to minor variations depending on any special requirements of their prescribed syllabus. In making the recommendations the Panel has not taken into account a very important development in modern science teaching, namely, the development of scientific hobbies which will serve both to discover scientific talent and to foster it in pupils. For this, it is necessary to provide a workshop where pupils can carry out scientific projects, make improvised apparatus, etc. and contribute usefully to the working of the classes.



CHAPTER II

PLANNING OF LABORATORIES

1. *Basic Requirements.*

1.1 Since the main function of a laboratory is to impart scientific education in an efficient way, its design should, therefore, be based on functional requirements. In determining the total area for a laboratory, the following factors were taken into consideration :—

- (a) The number of pupils working at a time.
- (b) The minimum space necessary for each pupil for comfortable work, taking into account the subject of study and the prescribed syllabus.
- (c) The necessity for providing some flexibility in the accommodation to give an opportunity to the teachers to re-group the classes so that demonstration experiments could be carried out conveniently with the participation of the pupils. This will also allow for changes in syllabus that may be necessary to keep pace with scientific progress.
- (d) Ancillary accommodation such as :
 - (i) room for storage of equipment and apparatus,
 - (ii) dark room for certain experiments,
 - (iii) balance room for chemistry laboratory, and
 - (iv) room for a gas plant.
- (e) Special provision necessary for certain laboratories such as fume cupboards for Chemistry, museums for Biology, kitchen and wash rooms for Home Science, etc.

2. *Functional Planning.*

2.1 *Location of Laboratories.*

The Panel considers that in the interest of economical distribution of layout and services, it would be advisable to locate the laboratories for Chemistry and Home Science on the ground floor and those for Physics and Biology on the first floor over these laboratories if the school buildings have a double-storeyed structure. For a single-storeyed structure, the grouping of Home Science with Chemistry and of Biology with Physics may still be kept intact. Both Chemistry and Home Science laboratories require special layouts for water and drainage which will be best arranged if they are both on the ground floor and adjacent to each other.

2.2. *Laboratory Space.*

Keeping in view the requirements described in section 1.1 above the Panel reconsidered the sizes of laboratories and of the various items of furniture

as also the total space recommended in various reports* published on the subject. The Panel is of the view that all the four laboratories *viz.* Physics, Chemistry, Biology and Home Science could be of the same size *i.e.*, $10.0 \text{ m} \times 6.0 \text{ m} = 60 \text{ sq. m.}$ ($32' \times 20' = 640 \text{ sq. ft.}$) with a space of $6.0 \text{ m} \times 3.7 \text{ m} = 22.2 \text{ sq. m.}$ ($20' \times 12' = 240 \text{ sq. ft.}$) provided for ancillaries for each laboratory. The Panel feels that the space requirement of 60 sq. m. for a batch of 24 students is the minimum that could be recommended for each laboratory. In making this recommendation the Panel has given considerable thought to the operational requirements in each laboratory and paid visits to several institutions with a view to find how best the economy of construction could be combined with efficiency, flexibility, practical lay-out of work tables, movement of supervising staff, lay-out of water and gas lines, etc. The Panel has even considered factors like proper placement of doors and windows and standardisation of lay-outs of electricity and gas fittings in the most economical way possible in addition to preserving interchangeability and structural economy as mentioned before.

A suggested lay-out appended to this report (Appendix II) shows the arrangements of the laboratories, ancillary rooms, work tables and other furniture.

2.3. Laboratory Lighting.

2.3.1 The factor of light, apart from affecting visual and physical comfort of students, involves the question of economy also in respect of the size and type of windows and of the disposition of light fittings. The chief purpose of lighting is to provide comfortable visual observation for laboratory work and the conservation of vision of the young workers. It is desirable to make maximum use of day-light by proper location of doors, windows and sky-lights. Windows are best placed at a standard sill height of 1.2 m. (4 ft.) from the finished floor level, as this would give a good distribution of light over the work tables whose height may vary between 85 cm. and 90 cm. (2'-9" and 3'). To save on capital as well as recurring expenses artificial lighting needs to be provided only for occasional work, for instance, during certain hours in winter and monsoon months. Windows and doors should be so disposed as to provide as evenly distributed illumination as possible. A window area of 20 per cent of the floor area is considered to be adequate for general laboratory work. In terms of lumens, the amount of day-light illumination of the order of 15 to 20 lumens per sq. ft. is considered to be adequate. The following reflectance standards are recommended for obtaining a desirable brightness level inside the laboratories :—

Ceilings	.	.	.	85%	of the total amount of light received by the surface.
Walls	.	.	.	60%	do.
Floors	.	.	.	15 to 30%	do.

*Report on Delhi School Buildings, Committee on Plan Projects, Planning Commission, 1960.

Planning Higher Secondary School Buildings, National Buildings Organisation, Ministry of Works, Housing & Supply, 1961.

Planning Schools for India, Ministry of Education, 1959.

2.3.2 Light and colour are closely inter-related so that in determining a suitable colour scheme inside the laboratory, the reflectance value should always be taken into account. White is not considered suitable for laboratory walls as it causes glare and shows dirt very prominently. Light cream or silver grey may be preferable.

2.4 Laboratory Services.

2.4.1. We recommend the provision of services in the various laboratories as follows :—

(1) *Physics Laboratory :*

(a) Power points. (230 volts, single phase, 10 amps.).

(i) Two each on the two side walls.

(ii) One in dark room for exhaust fan.

(iii) One on demonstration table.

(iv) One for charging batteries.

(b) *Plug points from light circuit*

(230 volts, single phase, 5 amps.)

(i) Two points distributed in the laboratory.

(ii) Four points in dark room.

(c) *Gas Supply*

(i) One gas tap on the demonstration table.

(ii) Three 2-way gas taps on the three tables on one side.

(to be fixed underneath the tables with connecting tubes for using the tap on the tables).

(d) *Water Supply*

(i) One tap with a sink on demonstration table.

(ii) Two taps with sinks for general use, one in the laboratory and one in store-cum-preparation room.

(2) *Chemistry Laboratory*

(a) *Power Points* (230 volts, single phase, 10 amps.)

(i) Two points for two exhaust fans.

(ii) Four points evenly spaced in the laboratory.

(iii) One point on demonstration table.

(iv) One point in the preparation room.

(b) *Gas Supply**

(i) Two 2-way gas taps for each work table.

(ii) One 2-way tap on demonstration table.

(iii) One tap in the preparation room.

*Care should be taken in selecting good quality gas taps as some of the cheaper makes start leaking very soon.

(c) Water Supply

- (i) Two taps to each work table with a common sink.
- (ii) One tap for demonstration table with sink.
- (iii) One tap for preparation room with sink.

(3) Biology Laboratory

- (a) *Power Point* (230 volts, single phase, 5 amps).

One power point on demonstration table.

- (b) *Plug point from light circuit* (230 volts, single phase, 5 amps.)

One on demonstration table.

- (c) *Light point*

One to each table (for microscopic work), if necessary.

- (d) *Water Supply*

- (i) Two taps with sinks at work tables as indicated in the plan.
- (ii) One tap on the demonstration table with sink.
- (iii) One tap in preparation room with sink.

(4) Home Science Laboratory

- (a) *Power points* (230 volts, single phase, 10 amps.).

- (i) Two for electric irons.
- (ii) Two for electric hot plates.
- (iii) One extra point.

- (b) *Gas Supply**

Four gas taps suitably placed in the laboratory and the kitchen.

- (c) *Water Supply*

Four taps with sinks in the laboratory and kitchen.

2.5 Laboratory Furniture :

2.5.1. Work table is the most important item of furniture and needs careful consideration. The size and design of this not only affects the size of the laboratory but has a bearing on cost. The Panel, therefore, considered this in detail in arriving at optimum standards.

2.5.2. Studies and surveys carried out by the Panel revealed considerable variation in the size and design of laboratory tables, for example, it is usual in the U.K. and U.S.A. to provide table surface area ranging from 5 to 15 sq. ft. per student, while in the laboratories visited by the Panel the average varied between 4.5 and 8 sq. ft. The Panel, after careful consideration of the functional requirements, now makes the following recommendations :—

- (1) Size of the work table need not be the same for all the four laboratories since the work carried out differs in each case.

*Where gas supply is not available, non-pressure type safety stoves may be substituted. Use of petrol gas plant is, however, recommended.

- (2) Work tables in the Physics, Chemistry and Home Science laboratories need not have drawers or closed cupboards. Biology tables, however, may preferably be provided with drawers. In Physics laboratory the work tables may be provided with 2 ft. wide intermediate shelves about 1 foot above the floor level.
- (3) Provision for tables should be made for 24 students in each laboratory
- (4) Sizes of work tables should preferably be as follows :—

Physics (for a group of four students).

1.8 m × 1.1 m × 90 cm. (6'—0" × 3'—6" × 3'—0") with a plain top and an intermediate shelf placed about 1 foot from the floor level.

Chemistry (for a group of four students)

1.8 m × 1.1 m × 85 cm (6'—0" × 3'—6" × 2'—9") with acid resistant top, with one sink in the middle having two taps and two reagent bottle racks on either side of the sink. These racks should be 60 cm. × 20 cm × 45 cm. (2'—0" × 8" × 1'—6") with intermediate tiers and should be constructed as separate pieces from the main table while capable of being screwed on the tops.

Biology

General work tables 1.8 m × 1.1 m × 85 cm. (6' × 3'—6" × 2'—9") with two sinks, one at each end, for dissection. Side tables of size 2.0 m. × 50 cm × 85 cm (6'—6" × 1'—8" × 2'—9") to be placed against walls and close to windows for microscopic work. These tables will have drawers and small cupboards below allowing sufficient space between cupboards as leg room.

Home Science

Suitable number of tables for

- (a) Cooking—50 cm wide × 80 cm high × length to suit the wall length (1'—8" × 2'—6") ;
- (b) Sewing machines—dimensions according to requirements; and
- (c) General purposes—1.8 m × 90 cm × 80 cm. (6'—0" × 3'—0" × 2'—6").

2.5.3 In addition to the above furniture, all the laboratories, except Home Science, should have a demonstration table 2.5 m × 80 cm. × 90 cm. (8'—0" × 2'—6" × 3'—0") with a sink at one end. A chalk board should be provided on the wall.

2.5.4 The laboratories should also have, in addition, soft pinning boards and wall show cases as indicated in typical lay-outs appended.

2.5.5 As for the material for furniture, the Panel feels that looking to the present conditions, timber is the most economical and easily available material in various parts of the country although steel facilitates lighter and neat-looking construction.

Note : For sketch designs of Physics & Chemistry tables, the Report on Delhi School Buildings may be referred to.

2.6. Ancillary Accommodation

2.6.1. The Panel has noticed that in most laboratories ancillary accommodation such as storage and balance room is often not provided or is grossly inadequate. It is, therefore, strongly recommended that such accommodation must form an essential part of the laboratory itself and should be well-planned in the same manner as the laboratory.

2.6.2. The Panel recommends the following standards for each laboratory :—

1. Physics.

- (a) Dark room $3.7 \text{ m} \times 2.7 \text{ m} = 9.99 \text{ sq. m.}$ ($12' - 0" \times 9' - 0" = 108 \text{ sq. feet.}$)
- (b) Store-cum-Preparation room $3.7 \text{ m} \times 3.3 \text{ m} = 12.21 \text{ sq. m.}$ ($12' - 0" \times 11' - 0" = 132 \text{ sq. ft.}$)

2. Chemistry

- (a) Balance room $3.7 \text{ m} \times 2.7 \text{ m} = 9.99 \text{ sq. m.}$ ($12' - 0" \times 9' - 0" = 108 \text{ sq. ft.}$)
- (b) Store-cum-preparation room
 $3.7 \text{ m} \times 3.3 \text{ m} = 12.21 \text{ sq. m.}$ ($12' \times 11' = 132 \text{ sq. ft.}$)

3. Biology

- (a) Museum-cum-preparation room
 $3.7 \text{ m} \times 3.3 \text{ m} = 12.21 \text{ sq. m.}$ ($12' \times 11' = 132 \text{ sq. ft.}$)
- (b) Store room $3.7 \text{ m} \times 2.7 \text{ m} = 9.99 \text{ sq. m.}$ ($12' \times 9' = 108 \text{ sq. ft.}$)

4. Home Science

- (a) Kitchenette-cum-preparation room
 $3.7 \text{ m} \times 3.3 \text{ m} = 12.21 \text{ sq. m.}$ ($12' \times 11' = 132 \text{ sq. ft.}$)
- (b) Store room $3.7 \text{ m} \times 2.7 \text{ m} = 9.99 \text{ sq. m.}$ ($12' \times 9' = 108 \text{ sq. ft.}$)

2.6.3. The Panel considers that there is no necessity of providing spacious store rooms for keeping stores and equipment. A comparatively smaller room, with well-designed shelving carried up to the ceiling, can provide enough storing space for the purpose. For reasons of economy and durability shelves and ledges of precast concrete type are recommended. Where, however, a store is used as a preparation room, a portion of the bottom shelf may have shutters forming lockable cupboards.

2.7 Height of Laboratories.

This aspect, though not vital from the point of view of educational requirements, is very important from the point of view of economy in construction. A height of the order of 12, 14 and even 16 feet is quite common in our country especially for public buildings in hot and dry regions. This can be conveniently reduced. The Panel, therefore, considers that a height of 3.3 m ($11' - 0"$) may be adequate. This will permit required depth of structural beams as well as sufficient room for fan and light fixtures.

CHAPTER III

EQUIPMENT & APPARATUS

1. Equipment and Apparatus in Science Laboratories :

1.1. The Board of Higher Secondary Education, Delhi, (now designated as the Central Board of Secondary Education) had drawn up a detailed list of equipment for Physics, Chemistry, Biology and Home Science Laboratories. The schools have, heretofore, been guided by this list for placing orders for the equipment required by them for each laboratory. This list was recently revised by the Board. A list of apparatus and equipment was also drawn at a "Workshop" organised by the Directorate of Education, Delhi in May 1962. The Panel made a detailed study of these lists. Besides, the lists of equipment, actually available for each of the four science subjects in a few representative schools of Delhi, were also prepared. Discussions were held with the science teachers and Principals of several schools. As a result of the data collected from all these sources and the subsequent discussions in several meetings, the Panel prepared its own list of apparatus and equipment for various laboratories.

1.2. The Panel made a detailed study of the cost involved in equipping the various laboratories. It was, however, not possible to arrive at correct figures in view of the varying prices given by the schools as also by the firms. Another factor which proved a handicap in making correct estimates of the cost was the availability of different makes of the same apparatus at highly divergent prices. For purpose of our study, we took into account the prices given by the "Workshop" mentioned above. As explained in subsequent paragraphs, the Panel decided to recommend that the procurement of equipment and apparatus for a school which was to introduce science subjects afresh may be spread over a period of three to four years. In the case of a school which is already imparting instruction in these subjects, the requirements will vary with reference to the available equipment and need for future development within the limits of the Panel's list.

1.3. An effort has been made to reconcile the apparently conflicting aims of economy and efficiency in equipping science laboratories. In order to obviate the necessity of incurring heavy expenditure in the initial stages for which there may not be adequate financial provision, the items have been grouped separately as "essential", "desirable" and "supplementary" as indicated in the note to the list.

CHAPTER IV

OTHER RECOMMENDATIONS

1. The Panel's detailed recommendations about the first two items of the Terms of Reference have been given in earlier chapters. The Panel gave considerable thought to the remaining four items and makes the following recommendations *ad seriatum* :

2. *Laying down specifications and standards for equipment and apparatus and procedure for quality control* :

The Panel feels that the laying down of specifications and standards for equipment and apparatus will greatly improve the quality of instruments at present being supplied to schools and recommends that the necessity for making these specifications may be brought to the notice of the Indian Standards Institution and the Central Scientific Instruments Organisation with the request that they may expedite the laying down of standards of at least those items of science apparatus which are already being manufactured in the country.

3. *Procedure for allotment of funds and procurement of equipment* :

The Panel very strongly recommends that the allotment of funds, both capital and recurring, should be made as early as possible so that the funds could be utilised before the end of the financial year. It has been brought to the notice of the Panel by several manufacturers that orders are usually placed with them so late in the year that they find considerable difficulty in supplying the articles in time. The Panel was made aware that many suppliers take advantage of the delay by dumping the worst quality materials at the very fag end of the financial year, and the school authorities could only reject the supplies at the risk of losing the grants. The Panel strongly recommends that the schools should be given the allotted grants before they close for the summer vacation and they should be instructed to place the orders for equipment before the schools re-open. Steps should then be taken for obtaining the equipment soon after the reopening of the schools.

4. *Possibility of having a centralised agency for the manufacture and procurement of scientific equipment.*

The Panel feels that, since a large number of firms are already engaged in the manufacture of scientific instruments, there is no necessity for a centralised agency for their manufacture. The procurement of science equipment, however, can be improved considerably if, for the new schools, package units, conforming to the prescribed equipment, were available to the schools by bulk purchases made through a suitable agency. It has come to the notice of the Panel that most of the Government purchasing agencies have to accept the lowest tenders according to the established procedure. This has led to deterioration in the quality of the instruments supplied and has encouraged progressive lowering of quality by manufacturers. The procedure of buying on the lowest tender needs to be replaced by a more rational

system whereby producers of quality goods may get an equitable price for their product. Where standards are available, purchases should be made strictly in accordance with the Indian Standards Institution standards or any other available standards.

5. Simplification of methods of work in the laboratories:

The Panel feels that, at present, there is considerable over-simplification of practical work. In most science laboratories only one teacher is available. With 20 to 24 students working at a time and trying to complete an experiment within a period of about 80 to 90 minutes the teacher is hardly able to do justice to the personal requirements of the pupils. The possibility of providing two demonstrators in each class deserves to be fully explored. It is also recommended that, wherever possible, full use should be made of the laboratory during the working hours and the possibility of two or more schools collaborating in practical work may be kept in view. If this is possible, the number of science teaching laboratories will not have to be increased in the same proportion as the number of schools.



APPENDIX I

LISTS OF EQUIPMENT AND APPARATUS

Note :

The lists of equipment and apparatus for Physics, Chemistry, Biology and Home Science laboratories, given below, are intended to indicate generally the minimum equipment that a school should have.

2. The quantities given are for a class of 40 students, working in two batches of 20 each, for practicals.

3. The "essential" items are to be acquired during the first two years of a new school and the "desirable" items in the subsequent three years. The "supplementary" items may be provided in the course of later years



A. PHYSICS

MAIN LIST

Demonstration

Sl. No.	Name of Article	Quantity	
		Essential	Desirable
1	Bell jar 20 cm. (8 in.) diam.	2	..
2	Glass cutting knife . . . . .	..	I
3	Reading Telescope . . . . .	..	I
4	Sun dial	I	..
5	Vernier model—wooden . . . . .	..	I
6	Wheel and axle . . . . .	..	I
7	Pulleys, various types (set of 24)	I	..
8	Differential pulley . . . . .	..	I
9	Young's modulus apparatus : Searle's . . . . .	..	I
10	Young's modulus apparatus : Vernier type	I	..
11	Hook's law apparatus with its kgm. wts. . . . .	..	I
12	Gear chain . . . . .	..	I
13	Centrifugal carriage . . . . .	..	I
14	Centre of gravity toys : set	3	..
15	Double cone and inclined plane	I	..
16	Globe, rotating . . . . .	..	I
17	Guinea and feather apparatus . . . . .	..	I
18	Falling plate apparatus . . . . .	..	I
19	Inertia apparatus (ball and spring type)	I	..
20	Brass strips to show flattening of the earth . . . . .	..	I
21	Cone . . . . .	..	I
22	Barker's mill . . . . .	..	I
23	Apparatus to show that liquids seek their own level	I	..
24	Hydrometers for light and heavy liquids : set . . . . .	..	I
25	Hydrometer for battery testing . . . . .	..	I
26	Bucket and cylinder . . . . .	..	I
27	Hydrostatic balance	I	..
28	Pascal's law apparatus	I	..
29	Wet and dry bulbs hygrometer	I	..
30	Daniel's hygrometer and Regnault's hygrometer (one each)	I	..
31	Hydrostatic paradox apparatus . . . . .	..	I
32	Model of submarine . . . . .	..	I
33	Model of hydraulic press	I	..
34	Lactometer	I	..
35	Vasudeo cup	I	..
36	Water wheel—model . . . . .	..	I
37	Baroscope . . . . .	..	I
38	Aneroid Barometer	I	..

Sl. No.	Name of Article	Quantity	
		Essential	Desirable
39	Fortin's Barometer	I	..
40	Rain gauge	I	..
41	Syringe	I	..
42	Hero's fountain . . . . .	..	I
43	Cartesian diver	I	..
44	Vacuum pump (piston type)	I	..
45	Vacuum pump (simple rotary type) . . . . .	..	I
46	Hand pump—model	I	..
47	Petrol pump—glass model	I	..
48	Force pump—glass model	I	..
49	Foot ball pump	I	..
50	Bicycle pump	I	..
51	Magdeberg hemispheres 12.7 cm. (5 in.) diam. (pair).	I	..
52	Harrison's grid bar pendulum . . . . .	..	I
53	Rutherford's maximum thermometer	I	..
54	Rutherford's minimum thermometer	I	..
55	Six's maximum and minimum thermometer	I	..
56	Clinical thermometer	I	..
57	Thermometer 0—50°C, marked in 1/5°C	2	..
58	Thermometer tube with cup at the top	I	..
59	Bunsen's ice calorimeter	I	..
60	Differential air thermoscope	I	..
61	Linear expansion apparatus (spherometer type) . . . . .	..	I
62	Constant volume air thermometer . . . . .	..	I
63	Constant pressure air thermometer . . . . .	..	I
64	Scarle's thermal conductivity apparatus . . . . .	..	I
65	Thermos flask	I	..
66	Newton's law of cooling apparatus . . . . .	..	I
67	Mechanical equivalent of heat apparatus (Scarle's apparatus or Joule's original calorimeter type) . . . . .	..	I
68	Working model of steam engine (sectional)	I	..
69	Model of gas engine	I	..
70	Model of speed governor (centrifugal force) . . . . .	..	I
71	Papin's digester . . . . .	..	I
72	Du long and Petit's apparatus	I	..
73	Hope's apparatus	I	..
74	Davy's safety lamp	I	..
75	Bar and gauge & ball and ring for expansion (each)	I	..
76	Wollaston's cryophorus . . . . .	..	I
77	Bar, soft iron & compound metal 100 cm. (each)	I	..
78	Strip, compound metal	I	..
79	Convection current apparatus (Set)	I	..

Sl. No.	Name of Article	Quantity	
		Essential	Desirable
80	Thermopile . . . . .	..	I
81	Fire alarm . . . . .	..	I
82	Crook's radiometer	I	..
83	Leslie's cube	I	..
84	Ritchie's apparatus	I	..
85	Total internal reflecting prism.	I	..
86	Magic lantern	I	..
87	Sextant (simple mirror type without telescope) . . . . .	..	I
88	Periscope (model)	I	..
89	Newton's coloured disc.	I	..
90	Kaleidoscope	I	..
91	Phosphorescence and fluorescence materials (set of four) . . . . .	..	I
92	Apparatus for determining critical angle . . . . .	..	I
93	Terrestrial telescope . . . . .	..	I
94	Model of reflecting telescope . . . . .	..	I
95	Stereoscope with slides . . . . .	..	I
96	Photographic camera with accessories . . . . .	..	I
97	Spectrometer (vernier type) . . . . .	..	I
98	Bunsen's grease spot photometer . . . . .	..	I
99	Rumford's photometer	I	..
100	Colour slide for showing the effects of mixing colours and pigments—set	I	..
101	Eye model with detachable parts	I	..
102	A pair of tuning forks mounted for beats . . . . .	..	I
103	Siren, with speed counter	I	..
104	Toothed wheel . . . . .	..	I
105	Sonometer . . . . .	..	I
106	Demonstration apparatus for wave motion	I	..
107	Organ pipes : set . . . . .	..	I
108	Floating magnets (De la Rive) . . . . .	..	I
109	Magnetic compass (medium size) . . . . .	..	I
110	Mariner's compass	I	..
111	Dip Circle	I	..
112	Horse shoe magnet 14 cm. ($5\frac{1}{2}$ in.)	I	..
113	Spherical conductor	I	..
114	Plate condensers in series and in parallel . . . . .	..	I
115	Rod, glass & brass	I	..
116	Faraday's butterfly net	I	..
117	Electrostatic machine (Wimshurst's) 30cm (12 in.) diam.	I	..
118	Leyden jars, small (removable)	I	..
119	Leyden jars, fixed coatings	I	..

Sl. No.	Name of Article	Quantity	
		Essential	Desirable
120	Apparatus for demonstrating the magnetic effect of currents (set)	..	I
121	Tangent galvanometer	I	..
122	Post Office Box	..	I
123	Moving coil galvanometer for lecture demonstration	..	I
124	Electric motors (4 to 6 volts) AC/DC	..	I
125	Electromagnet, lifting (10 kg.)	..	I
126	Electric dynamo AC/DC (working model)	..	I
127	Induction coil 10 cm (4 in.) spark	..	I
128	X-ray tube with screen and stand	..	I
129	Telegraph arrangement (set)	I	..
130	Telephone arrangement (set)	..	I
131	Discharger	I	..
132	A set of discharge tubes under different pressures and for different gases	..	I
133	Bunsen's cell	I	..
134	Bichromate cell	I	..
EXPERIMENTS			
<i>Mechanics and General Properties of Matter</i>			
135	Glass jug	I	..
136	Glass trough.	2	..
137	Laboratory supports and clamps (various types)	12	..
138	Burette clamp, spring type	6	..
139	Balance, physical (with weight box)	6	2
140	Spring Balance :		
	1 lb.	I	..
	100 gms.	3	..
	250 gms.	3	..
141	Meter scales		
	Full meter	10	..
	Half meter	20	..
142	Micrometer screw gauge	4	I
143	Vernier Caliper	4	I
144	Ordinary calipers	4	I
145	Spherometer.	4	I
146	Stop clock	4	I
147	Stop watch	2	..
148	Spirit level	4	I
149	Graduated cylinders		
	50 cc.	2	I
	100 cc.	5	5
	250 cc.	2	1
	500 cc.	2	6

Sl. No.	Name of Article	Quantity	
		Essential	Desirable
150	Burette	4	2
151	Pipette	4	..
152	Apparatus for composition of forces	4	..
153	Inclined plane for determination of the co-efficient of friction	4	..
154	Bobs for pendulum (in place of simple pendulum)	12	3
155	Specific gravity bottle	5	5
156	Nicholson's hydrometer	4	..
157	Boyle's Law apparatus	4	..
158	Travelling microscope	1	..
159	Wooden wedges	4	2
160	Hare's apparatus with wooden stand	4	2
161	U-Tube with wooden stand	4	2
162	Barometer tubes	5	..
163	Calcium chloride tubes . . . . .	..	5
164	Small wooden benches for relative density	6	..
165	Wooden blocks, assorted (Doz.)	2	..
166	Tripod stands 23 cm. (9 in.)	6	..
167	Test tubes	72	..
168	Petri dishes 15 ¹ / ₂ cm. (6 in.)	2	..
169	China dishes 10 cm. (4 in.)	2	..
170	Crucibles with lids	2	..
171	Trough (G.I.) 38 cm. (15 in) diam.	6	..
<i>Heat and Light</i>			
172	Thermometer : 0—212°F]	6	2
	—10—110°C	8	4
173	Calorimeter, with stirrer and wooden box	4	2
174	Boiler, copper 1000 cc.	4	..
175	Hypsometer	4	..
176	Stove . . . . .	..	2
177	Spirit lamp, brass 170 gms. (6 oz.)	12	..
178	Wire gauze screen 15 × 10 cm (6" × 4")	12	12
179	Mirrors : Plane strip with stand	24	..
	Concave, 5 cm. (2 in.) diam.	4	..
	Concave, 6.3 cm. (2½ in.) diam.	4	4
	Concave, 7.6 cm. (3 in.) diam.	4	..
	Convex, 6.3 cm. (2½ in.) diam.	4	..
180	Lenses : Double Convex 5 cm. (2 in.)	10	4
	Double Convex 7.6 cm. (3 in.)	4	2
	Double Convex 5 cm. (2 in.)	4	2
181	Prisms : Glass	4	2
	Hollow	4	2

Sl. No.]	Name of Article	Quantity	
		Essential	Desirable
182	Glass slabs for refraction experiments :		
	Slabs $8 \times 5 \times 2.5$ cm. ($3.2'' \times 2'' \times 1''$)	4	2
	Hollow cubes (for liquid)	4	2
183	Magnifying lens	2	..
184	Optical bench with accessories (Metal)	4	..
185	Lens holders	4	..
186	Ground glass screens 15×10 cm. ($6'' \times 4''$)	4	..
<i>Sound, Electricity & Magnetism</i>			
187	Tuning forks	8	2
188	Resonance tube apparatus	4	..
189	Magnetic needle on pivot	4	..
190	Magnetic compass (small size for plotting lines of force) 15 mm. (0.6 in.)	6	2
191	Magnets—pairs (different types)	8	..
192	Deflection magnetometer	4	..
193	Vibration magnetometer	4	..
194	Pith ball pendulum	4	..
195	Ebonite rods	2	..
196	Glass rods 30×2 cm. ($12'' \times \frac{3}{4}''$)	2	..
197	Cat skin (full piece)	2	..
198	Flannel piece	2	..
199	Rod, sealing wax	2	..
200	Biot's apparatus	5	..
201	Proof plane with ebonite rod	5	..
201	Gold leaf electroscope	4	..
202	Electrophorus	4	..
203	Cells : Leclanche Daniel	8	..
204	Accumulator 2 Volts	4	..
205	Potentiometer, slide wire type 400 cm.	4	..
206	Moving coil galvanometer—Weston type	4	2
207	Meter bridge	4	..
208	Resistance box	4	..
209	Rheostat 10, 25, 50, & 150 ohms	4	2
210	Ammeter	4	1
211	Voltmeter	4	1
212	Copper Voltmeter	4	..
213	Plug keys : One way	4	..
	Dobule key	4	..
	Triple key	2	..
214	Transformers—small : step up & step down	4	..

Sl. No.	Name of Article	Quantity	
		Essential	Desirable
Miscellaneous.			
215	Rubber tubing ordinary (metres)	10	..
216	Pressure tubing (metres)	10	..
217	Nails assorted (kg.)	1	..
218	Screws and nuts assorted (gross)	2	..
219	D.C.C. enamelled wire No. 22 (kg.)	$\frac{1}{2}$	..
220	D.C.C. enamelled wire No. 26 „	1	..
221	D.C.C. enamelled wire No. 30 „	..	$\frac{1}{2}$
222	D.C.C. enamelled wire No. 32 „	..	$\frac{1}{4}$
223	Plastic wire coil	1	..
224	Flexible wire coil (silk covered)	..	1
225	Manganin wire 32 gauge (Gms.)	..	100
226	Nichrome wire 30 gauge „	..	100
227	Eureka wire 30 gauge „	100	..
228	Iron wires of different diameters (1 mm to 5 mm) (kg.)	..	$\frac{1}{2}$
229	Mercury (kg.)	5	..
230	Geometrical instruments set	1	..
231	Cork borer-set of three	2	..
232	Emery paper, assorted	12	..
233	Grease (kg.)	$\frac{1}{2}$	..
234	Insulating tape (reel)	1	..
235	Lycopodium powder (gm.)	..	30
236	Rubber pads	4	..
237	Pestle and mortar	1	..
238	Lead shots (kg.)	$\frac{1}{2}$	..
239	Asbestos pieces 15×15 cm. (6''×6'')	6	..
240	Bucket, galvanized	2	2
241	Basin (china clay) 10 cm. (4'')	..	4
242	Test tube brushes (doz.)	3	..
243	Corks, assorted (gross)	1	..
244	Glass rods assorted (kg.)	$\frac{1}{2}$	..
245	Glass tubing capillary (kg.)	3	..
246	Watch glass	6	..
247	Electric bulbs with holders	24	..
248	Switches	12	..
249	Cut outs	12	..
250	Two-pin plugs	6	..
Set of tools.			
251	Pliers, assorted	3	..
252	Screw drivers assorted	6	..
253	Files assorted	12	..
254	Chisels, assorted	3	..

Sl. No.	Name of Article	Quantity	
		Essential	Desirable
255	Hand drill	1	..
256	Bench vice 10 cm (4 in) gap	1	..
257	Grinder	1	..
258	Metal cutting saw with blades	1	..
259	Plane 20 cm (8 in.)	1	..
260	Hammers, assorted	3	2
261	Tongs	1	1
262	Nail pullers	1	1
263	Forceps	1	1
264	Soldering iron (75 & 120 Watts)	1	1
265	Pair of compasses	1	1
266	Dividers	1	1
267	Metal scale	1	1



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SUPPLEMENTARY LIST

Sl. No.	Name of Article	Quantity
1	Measuring tape (25 m.)	1
2	Gyroscope	1
3	Spiral spring for demonstrating the properties of simple harmonic motion	1
4	Flush model siphon (glass)	1
5	Steel yard (Roman)	1
6	Apparatus to show that upward, downward and sidewise pressures are equal	1
7	Mousson's apparatus for showing the effect of pressure on melting point	1
8	Model for the determination of 'G' (Cavendish method)	1
9	Working model of hydro-electric plant	1
10	Model of air plane	1
11	Pressure gauge (Bourdon's type)	1
12	Atwoods' machine	1
13	Whirling table in vertical and horizontal positions	1
14	Ball-bearing sectional model	1
15	Hydrostatic bellows	1
16	Apparatus to show liquid pressure with manometer	1
17	Jolley's differential steam calorimeter	1
18	Thermostat model	1
19	Dilatometer	1
20	Model of ammonia ice plant	1
21	Direct vision spectroscope	1
22	Film strip projector	1
23	Binocular	1
24	Hartle's optical disc for demonstration of experiments	1
25	Polaroid discs—pair	1
26	Epidiascope	1
27	Electrically maintained tuning fork	1
28	Quincke's interference tube	1
29	Gramophone with records	1
30	Singing flame apparatus	1
31	Earth inductor	1
32	Magnetic globe-medium size	1
33	Hibbert's magnetic balance	1
34	Coloumb's torsional balance	1
35	Electric chime, electric whirls, Faraday's ice pail etc. for demonstrating the basic phenomena in electrostatics	1
36	Moving coil galvanometer for lecture demonstration	1
37	Electromagnetic induction apparatus (set)	1
38	Apparatus for determining the specific heat of solids by the method of mixture (Regnault type).	4

Sl. No.	Name of Article	Quantity
39	Ebonite sheet (sq. m.)	0.4
40	Rubber sheet (sq. m.)	0.8
41	Leather sheet (assorted sizes) (sq. m)	0.4
42	Brass metal rods. (assorted sizes) (kg.)	1
43	Brass metal sheets (assorted sizes) (kg.)	2
44	Brass metal tubing (assorted sizes) (kg.)	1
45	Banana plugs and sockets. (doz.)	1
46	Crocodile clips (doz.)	1
47	Terminals, assorted (doz.)	3



सत्यमेव जयते

B. CHEMISTRY

Demonstration

Sl. No.	Name of Article	Quantity (Essential)
1	Aspirator (1 litre capacity)	1
2	Bell Jar 20 cm (8 in) diam.	1
	Funnel, separating.	2
4	Funnel Buchner 65 mm (2.6 in)	1
5	Calcium chloride tubes	4
6	Thermometers (marked in $\frac{1}{2}^{\circ}\text{C}$)	4
7	Voltmeter for electrolysis	1
8	Voltmeter for electrolysis of hydrochloric acid	1
9	Eudiometer tube : straight (with platinum terminals)	1
10	Fractionating columns and tubes (various types) 46 cm-(18") high	4
11	Mercury trough	1
12	Filter pump (steel)	1
13	Porcelain boats	4
14	Crystal models (glass/wooden/plastic) (set)	1
15	Diffusion apparatus	1
16	Ozone apparatus (Sieman's & Brodie's ; 1 each)	2
17	Potassium hydroxide bulbs	2
18	Victor Meyer's apparatus with copper jackets, Hoffmann bottle and graduated tube	2
19	Apparatus for dialysis (dialyser)	1
20	Combustion tubes	2
21	Burthel burner	1
22	Copper still for distillation—10 litres (preferably electrically operated)	1
23	Platinum wires (5 cm. pieces fused in glass)	2
24	A set of process charts including periodic table	1
25	Atomic model (set)	1
26	Mineral collection (set)	1
27	Alloys (set)	1
28	First-aid cabinet	1

Experiments

(Starred items are required in large quantities and may be supplied as needed)

Sl. No.	Name of Article	Quantity	
		Essential	Desirable
29	Sand bath "	20	4
30	Water bath, small (copper)	20	4
31	Cobalt glass	6	..
32	Beaker : 150 m.l. Capacity . . . . .	..	25
	250 m.l. "	60	20
	500 m.l. "	20	5
33	Beehive shelf	20	4
34	Flask (F.B.) 500 m.l.	30	..
35	Flask (R.B.) 500 m.l.	30	..
36	Flask, conical (250 cc.) (Erlmeyer type)	30	30
37	Funnel 7'6" x 10 cm. (3" x 4")	60	..
38	Funnel, thistle (gross)	1	..
39	Evaporating porcelain basin 2 cm (3/4") diam.	30	10
40	Retort : 250 m.l.	30	..
	500 m.l. . . . .	..	5
41	Funnel stand	20	4
42	Tripod stand	20	4
43	Trough (glass) 25 cm. (10 in) diam.	24	..
44	Deflagrating spoon	30	..
45	Drying cone (G.I.)	12	..
46	Asbestos sheet : 15 x 15 cm (6" x 6")	30	18
47	Flame protector	24	..
48	Iron stands with clamps and rings	20	4
49	Cork borers—set of 3 each	20	4
50	Cork presser	2	..
51	Corks velvet (ordinary) assorted sizes (gross)	10	..
52	Stoppers, rubber : assorted sizes (doz.)	6	..
53	Mortars and pestles (Porcelain) 15 cm (6")	3	3
54	Spatula (horn)	6	6
55	Triangular files 15 cm (6")	20	4
56	Round files 15 cm (6")	12	..
57	*Glass tubing different diam. (kgs.)	25	..
58	*Rubber tubing, assorted sizes (metres)	50	..
59	*Glass rods (kgs.)	4	..
60	Woulffe's bottles 250 m.l.	24	..
61	Watch glass (different sizes)	40	20
62	Gas jar 20 cm. (8")	100	60
63	Glass disc (for the above jars)	100	100
64	Glass disc with hole	30	10
65	Filter paper packet (100 pieces)	10	..
66	Filter paper sheet	50	..

Sl. No.	Name of Article	Quantity	
		Essential	Desirable
67	Wire gauze piece (asbestos covered).	30	..
68	Hard glass test tubes 15×2.5 cm. ($6'' \times 1''$) (doz.)	6	..
69	Test tubes $15 \times .95 \times 1.6$ cm. ($6'' \times \frac{1}{2}'' \times \frac{1}{2}''$) (gross)	5	5
70	Test-tube holder	20	4
71	Test-tube stand	24	..
72	Kipp's apparatus : 1000 m.l.	1	..
	500 m.l.	1	1
73	Charcoal blocks (doz.)	4	..
74	Reagent bottles-flat stoppered and narrow mouthed (226 gm.) (doz.)	25	5
75	Reagent bottles-wide mouthed (226 gm.)	150	50
76	Test-tube brushes	24	24
77	Mouth blow pipes	20	4
78	Desiccator with lid and perforated porcelain plate 12.7 cm. ($5''$)	20	..
	Do. 15 cm. ($6''$)	..	6
79	Clay pipe triangles	20	16
80	Pair of tongs (brass)	20	4
81	Crucible, porcelain with lid	20	4
82	Crucible, silica with lid	1	1
83	Sand paper sheet	12	..
84	Burette 50 m.l. with stop cock	5	..
	" with pinch cock	20	10
85	Pipette 10 c.c.	30	..
	" 20 c.c.	..	30
86	Measuring flask 1000 c.c.	2	2
	500 c.c.	5	5
87	Measuring jar 500 c.c.	2	..
88	Winchester bottle (5 litres)	6	6
89	Liebig's condenser 30 cm. ($12''$)	12	..
90	Burette stand/holder, Fischer type (metal)	20	4
91	Balance, analytical with weight box 1 m.g. sensitiveness	5	1
92	Physical Balance with weight box (250 gms.)	1	1
93	Petrol gas plant-automatic reservoir suitable for 24 burners (with accessories)	1	..
94	Burners suitable for petrol gas plant	24	..
95	Spirit lamps-brass (113 gm.)	20	4
96	Blow lamp	1	..
97	Pressure type stove	2	2

Chemicals

An amount of Rs. 2,000 may be provided annually towards the purchase of the necessary chemicals for the Chemistry Laboratory.

C. BIOLOGY**1. Vegetative parts**

The following modifications of vegetative parts may be collected and preserved where necessary.

ROOT:

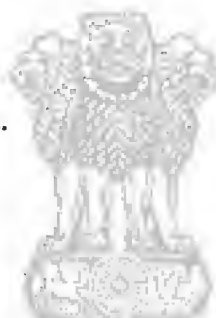
- (i) Fusiform root of radish.
- (ii) Napiform root of turnip.
- (iii) Conical root of carrot.
- (iv) Tuberous root of sweet potato or seven O'clock plant.
- (v) Nodulated root of groundnut.
- (vi) Parasitic root of *Cuscuta* . . .
- (vii) Fasciculated root of asparagus.
- (viii) Climbing root of beetle.
- (ix) Assimilatory root of *trapa*.
- (x) Leaf root of *bryophyllum*.
- (xi) Adventitious root of grass.

STEM :

- (i) Rhizome of ginger.
- (ii) Tuber of potato.
- (iii) Bulb of onion.
- (iv) Corm of colocasia.
- (v) Sucker of mint.
- (vi) Phylloclade of *ruscus*.
- (vii) Cladode of asparagus.
- (viii) Thorn of *duranta*.
- (ix) Bulbil of lily.
- (x) Spine of prickly pear.
- (xi) Tendril of vine.

LEAF :

- (i) Tendril of pea.
- (ii) Phyllode of Australian acacia.
- (iii) Pitcher of *Nepenthes*.
- (iv) Leaf of sundew.
- (v) Bladder wort (entire plant).



II. Apparatus

Sl. No.	Name of Article	Quantity	
		Essential	Desirable
1	Microscopes with oculars X 10 Objectives X 10X40 . . .	5	..
2	Dissecting microscopes : rack and pinion . . .	8	2
3	Reading glass (Magnifier) 7.6 cm. (3") diam. . . .	2	..
4	Magnifiers single folding	20	..
5	Magnifiers triple folding	1	1
6	Eye piece X 10 with pointer	2	..
7	Klinostat	1	..
8	Aquaria glass clear 30 litres 61×38×30 to 35 cm. (24"×15"×12" to 14")	1	1
9	Thermometers 0—110°C	2	..
10	Thermometers 0—220° F	2	..
11	Physical balance with weight box	1	..
12	Beranger's balance with weight box	1	..
13	Cage for small animals	1	..
14	Thermos flask (wide mouthed) 1 litre	1	..
15	Respiroscope ordinary	3	3
16	Ganong's respiroscope	1	1
17	Auxonometer	1	..
18	Ganong's potometer	1	..
19	Ganong's light screens	3	3
20	Apparatus to show suction force	1	1
21	Apparatus to show the relationship between transpiration and absorption.	1	..
22	Heliotropic chamber	1	..
23	Simple potometers	2	..
24	Moll's apparatus	1	..
25	Apparatus to measure root pressure	1	..

III. Laboratory Equipment.

26	Dissecting trays enamel or zinc painted (large)	20	4
27	Dissecting set for teacher	4	..
28	Bone cutting Forceps	6	..
29	Big scissors	4	..
30	Hammers (small)	10	..
31	Mounted needles (cross)	1	..
32	Boards, insect drying	2	..
33	Boards, insect setting	2	..
34	Slide boxes each to hold 25 slides (empty)	10	..
35	Brushes camel hair (assorted sizes)	20	10
36	Herbarium Press 50×30 cm. (20"×12") (wooden boards with reapers) (pair)	1	..
37	Drying papers	200	200
38	Herbarium mounting sheets	100	100

Sl. No.	Name of Article	Quantity	
		Essential	Desirable
39	Secateur 12.7 cm. (5")	1	..
40	Digger	2	..
41.	Cork borer (Hand)	1	..
42.	Cork boring machine	..	1
43.	Retort stands with clamps and boss heads	6	..
44.	Funnel stands (wooden)	6	6
45.	Test-tube stands	6	6
46.	Wire cages to hold test tubes	6	6
47.	Collecting nets	6	..
48.	Pins, assorted sizes for fixing specimens (pkts)	10	..
49.	Entomology Pins (gross)	1	..
50.	Iron tripod stands	6	..
51.	Spirit lamps	5	1
52.	Rubber tubing (4 sizes of 5 m. each)	20	..
53.	Rubber corks (assorted sizes) (doz.)	2	..
54.	Cork bark (assorted) (gross)	1	..
55.	Razors hollow ground	2	1
56.	Scalpels	5	..
57.	Forceps 12.7 cm. (5") pointed (steel)	5	..
	12.7 cm. (5") blunt	5	..
58.	Forceps (long) 30 cm. (12")	2	..
59.	Forceps 7.6 cm. (3") pointed	2	..
60.	Spatulas	3	..
61.	Pinch cocks (screw type)	6	6
62.	Kerosene stoves (non pressure type) (where gas is not available)	1	..
63.	Vasculum	4	..
64.	Pruning knife	1	..
65.	Trowel	1	..
66.	Test tube holders	10	2
67.	Flower pots (assorted, earthenware) 20 & 25 cm. (8" & 10")	12	12
	15 cm. (6")	12	12
68.	Watering can (galvanized)	2	..
69.	Mugs (enamel)	4	..
70.	Baltis (15 litres capacity)	2	2
71.	Refuse box with lid	2	..
<i>IV. Glass-ware & Museum ware</i>			
72.	Bell Jar 50 x 30 cm. (20" x 12")	1	1
73.	Glass plate 35 x 35 cm. (14" x 14")	2	1
74.	Aspirator (10 litres)	1	1
75.	Funnel 10 cm. (4") diam	6	..
	Funnel 7.6 cm. (3") diam	6	..
	Funnel 5 cm. (2") diam	4	..

Sl. No.	Name of Article	Quantity	
		Essential	Desirable
76.	Beaker 1 litre	3	..
	Beaker 1/2 litre	6	6
	Beaker 1/4 litre	24	..
77.	Flask Erlynmeyer 1 litre	3	..
	Flask Erlynmeyer 1/2 litre	3	..
	Flask Erlynmeyer 1/4 litre	6	..
78.	Battery jar, cylindrical 1 litre	2	..
79.	Museum jars 20 × 5 × 20 cm. (8" × 2" × 8")	20	..
80.	Museum jars, cylindrical with covers (different sizes) (doz.)	6	..
81.	Flask—(Round bottom) 1/2 litre	2	..
	Flask—(Round bottom) 1/4 litre	4	..
82.	Funnel, thistle	6	..
83.	Gas jar with lid (doz)	2	..
84.	Microscope slides 7.6 × 2.5 cm. (3" × 1") (gross)	1	..
85.	Cover glass 2.5 × 2.5 cm. (1" × 1") or 2.2 × 2.2 cm. (3/4" × 3/4") (doz)	2	..
86.	Watch glass 5 cm. & 7.6 cm. (2" & 3")	100	..
87.	Embryo cup with scooped inside 25 sq. cm. & 56 sq. cm. (2" sq. & 3" sq.)	20	5
88.	Hard glass test tube (thick wall) 15 × 3.75 cm. (6" × 1 1/4")	12	..
89.	Test tube (ordinary) 15 × 2.5 m. (6" × 1") (gross)	1	..
90.	Bottles with bakelite screw caps (different capacities) (doz).	1	..
91.	Reagent bottles (narrow mouthed) :		
	226 gm. (doz).	1	..
	113 gm. (doz.)	2	..
92.	Drop bottle (doz.)	1	..
93.	Stain bottle (doz)	1	..
94.	Winchester bottle (2 1/2 litres capacity)	0	..
95.	Glass tubing (assorted sizes) (kg.)	2.5	..
96.	Pipette 10 cc	6	..
97.	Burette 50 cc.	3	..
98.	Finger bowls	20	4
99.	Circular glass troughs 30 cm. (12 in.)	2	..
100.	Display case (with glass top) 50 × 40 × 3.75 cm (20" × 16" × 1 1/4")	6	..
101.	Desiccators (different sizes)	2	..
102.	Petri dishes 15 cm. (6") diam. (doz.)	1	..
	„ 10 cm. (4") diam. (doz.)	2	..
103.	Hang drop slide	3	..
104.	Capillary tube (kg)	1	..
105.	Enamel tray 30 × 23 cm. (12" × 9")	4	..
	23 × 15 cm. (9" × 6")	20	..

V. Chemicals

(Starred items are required in large quantities and may be supplied as needed)

Sl. No.	Name of Article	Quantity (Essential)
106	Absolute alcohol—(litre).	$\frac{1}{2}$
107	*Rectified spirit—(litre)	10
108	*Methylated spirit—(litre)	10
109	Canada balsam—(gms.)	200
110	*Iodine crystals—(gms.)	100
111	Potassium iodide—(gms.)	100
112	Sodium chloride—(gms.)	500
113	Potassium hydroxide stick—(gms.)	200
114	*Picric acid pure—(gms.)	200
115	Mercuric chloride —(gms.)	250
116	*Formalin (commercial formaldehyde) (litres)	5
117	*Glycerine—(gms.)	500
118	*Petroleum jelly or vaseline white (kg.)	$\frac{1}{2}$
119	Ammonia liquor (cc)	500
120	Agar agar shreds (gms.)	200
121	*Pyrogalllic acid—(gms.)	100
122	*Mercury—(kg.)	1
123	Clove oil—(c.c.)	100
124	Xylol—(kg.)	$\frac{1}{2}$
125	Starch soluble—(gms.)	100
126	Cobalt chloride—(gms.)	200
127	Gum arabic—(gms.)	100
128	Paraffin wax commercial (kg.)	20
129	Filter paper (pkts. of 100 each)—(kg)	5
130	Chloroform—(kg.)	2
131	Plaster of paris (kg.)	2

Stains

132	Eosin—(gms.)	10
33	Safanin—(gms.)	10
134	Methylene blue—(gms.)	5
135	Haematoxylin—(gms.)	10
136	Light green —(gms.)	10
137	Congo red —(gms.)	10
138	Malachite green—(gms.)	10
139	Gentian violet—(gms.)	5

Sl. No.	Name of Article	Quantity	
		Essential	Desirable
VI. TOOLS			
140	Chisel	2	..
141	Hammer	1	..
142	Screw drivers, assorted sizes	6	..
143	Cutting plier	1	..
144	Drill with bits (set)	1	..
145	Knives, grafting	1	..
146	Hand saw	1	..
147	Table vice 15 cm.	1	..
148	Flat file 15 cm. (6 in).	4	..
149	Triangular file	1	..
VII. CHARTS <i>Botany</i>			
150	Cell division, mitosis	1	..
151	Structure of dicot stem	1	..
152	Plant tissues	1	..
153	Structure of monocot stem	1	..
154	Structure of leaf	1	..
155	Structure of dicot root and monocot root	1	..
156	Structure of root tip	1	..
157	Parts of a typical plant	1	..
158	Modifications of root	1	..
159	Modifications of stem	1	..
160	Typical flower and its parts	1	..
161	Aestivation	1	..
162	Androecium and gynoecium	1	..
163	Placentation	1	..
164	Fruits—different kinds of fleshy and dry fruits	1	..
165	Seeds—dispersal of seeds	1	..
166	Germination—epigeal and hypogeal	1	..
167	Monocot seed and parts	1	..
168	Dicot seed and parts	1	..
169	Algae—Chlamydomonas Spirogyra	1	..
170	Mucor or rhizopus	1	..
171	Mushroom	1	..
172	Bacteria	1	..
173	Yeast—structure & reproduction	1	..
174	Moss—life history	1	..
175	Fern—typical fern & its parts	1	..
176	Insectivorous plants	1	..
177	Vegetative propagation—grafting etc.	1	..
178	Food chain	1	..
179	Family—Ranunculaceae	1	..
	„ —Cruciferae	1	..
	„ —Malvaceae	1	..

Sl. No.	Name of Article	Quantity	
		Essential	Desirable
	Family —Solonaceae	I	..
	„ —Leguminosea	I	..
	„ —Labiatae	I	..
	„ —Graminaceae	I	..
	„ —Lilaceae	I	..
180	Different kinds of leaves and their modifications . . . . .	..	I
181	Kinds of corollas . . . . .	..	I
182	Nitrogen cycle in nature . . . . .	..	I
183	Root of leguminous plants showing nodules . . . . .	..	I
	<i>Zoology</i>		
184	Amoeba—structure and reproduction	I	..
185	Life cycle of malarial parasite	I	..
186	Liverfluke	I	..
187	Tape worm	I	..
188	Cell—typical	I	..
189	Roundworm—Ascaris—filarial	I	..
190	House fly—life hisotry	I	..
191	Mosquito—life history—culex	I	..
192	Butterfly —life history	I	..
193	Frog :		
	Organs in situ—dissection	I	..
	Alimentary canal	I	..
	Veinous system	I	..
	Arterial system	I	..
	Urinogenital system (Male and Female)	I	..
	Brain—different aspects and parts	I	..
	Nervous system	I	..
	Skeletal system	I	..
	Heart and its structure	I	..
	Skin T. S.	I	..
	Eye	I	..
	Ear	I	..
	Buccal cavity	I	..
	Life history	I	..
194	Various insects	I	..
195	Poisonous and non-poisonous snakes	I	..
196	Birds with various kinds of beaks and feet	I	..
197	Mammals of India—different kinds	I	..
198	Fishes—external features	I	..
199	Earthworm—external features . . . . .	..	I
200	Evolution (tree)	I	..
201	Prehistoric animals	I	..
202	Scene of pre-historic forest	I	..
203	A set of fossil plants and animals	I	..

Sl. No.	Name of Article	Quantity	
		Essential	Desirable

VIII. Slides

Botany

204	Typical cell and content	1	..
205	Root tip L.S. for mitosis (onion)	1	..
206	Root T. S. & L.S. of dicot root	2	..
207	Root T.S and L.S. of dicot root with secondary growth	2	..
208	Stem T.S. & L.S. of dicot stem	2	..
209	Stem T. S. & L.S. of dicot stem with secondary growth	2	..
210	Root T.S. & L.S. of monocot root	1	..
211	Stem T.S. & L.S. of monocot stem	1	..
212	Leaf structure of typical leaf	1	..
213	Leaf epidermis—peel to show stomata	1	..
214	Chlamydomonas	2	..
215	Spirogyra	2	..
216	Mucor or Rhizopus	1	..
217	Agaricus T.S. of gill	2	..
218	Moss L. S. of capsule	2	..
219	Root T. S. of Cuscuta	1	..
220	Root nodule of leguminous plant	2	..
221	Yeast cells	2	..
222	Anther T. S.	1	..
223	Ovule T. S.	1	..
224	Flower bud T. S.	1	..

Zoology

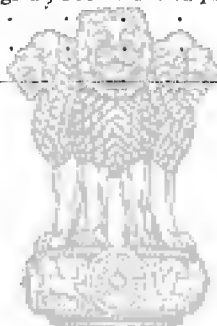
225	Amoeba	2	..
226	Blood of frog	2	..
227	Blood of man	2	..
228	Bone—T.S. (human)	1	..
229	Bone T. S. (frog).	2	..
230	Cell—epithelial	1	..
231	Earthworm T. S.	2	..
232	Hook worm—head	2	..
233	Liver fluke—entire	2	..
234	Malarial parasite	2	..
235	Mouth parts of butterfly	2	..
236	Mouth parts of mosquito	2	..
237	Mouth parts of house fly	2	..
238	Muscle, human : striped and unstriped	2	..
239	Tape worm—head	1	..
240	Tape worm—proglottis	2	..
241	Tracheal tube of an insect	2	..

Sl. No.	Name of Article	Quantity	
		Essential	Desirable
242	Hydra—whole mount	1	..
243	Hydra—T.S. & L.S.	1	..
244	Squamous epithelium of frog	2	..
245	Columnar epithelium of frog	2	..
246	Ciliated epithelium of frog	2	..
247	Striped muscle of frog	2	..
248	Unstriped muscle of frog	2	..
249	Cardiac muscle of frog	2	..
250	Cartilage (hyaline) of frog	2	..
251	Connective tissue of frog (areola)	2	..

IX. Mounted specimens

252	Leaf of drosera	1	..
253	Moss—full plant with capsule	1	..
254	Liverwort	1	..
255	Two or three kinds of poisonous snakes	1	..
256	Tape worm	1	..
257	Round worm	1	..
258	Silk moth—life history	1	..
259	Star fish	1	..
260	Sponge	1	..
261	Liver fluke	1	..
262	Earthworm	1	..
263	Leech	1	..
264	Prawn	1	..
265	Honey bee . . . . .	..	..
266	Mosquito—culex	1	..
267	Scorpions	1	..
268	Spider	1	..
269	Dog fish	1	..
270	Rohu fish	1	..
271	Frog life history	1	..
272	Chamaeleon	1	..
273	Tortoise	1	..
274	Bladderwort . . . . .	..	1
275	Pitcher of nepenthes . . . . .	..	1
276	Pine cone—male and female . . . . .	..	1
277	Anopheles mosquito . . . . .	..	1
278	Lizard . . . . .	..	1

Sl. No.	Name of Article	Quantity	
		Essential	Desirable
<i>X. Skeletons</i>			
279	Skeleton Articulated (frog)	4	..
280	Skeleton disarticulated (set)—(frog)	20	..
281	Skull disarticulated (set)—(frog)	2	..
282	Skeleton—snake's	1	..
283	„ —Bird's	1	..
284	„ —Rabbit's	1	..
285	„ —Fish's	1	..
<i>XI. Models</i>			
286	Frog's brain	1	..
287	Bird's brain	1	..
<i>XII. Audio-visual aids</i>			
288	Films and film strips on biological, botanical and physiological topics (set)	1	..
289	Film strip projector	1	..



सत्यमेव जयते

HOME SCIENCE

MAIN LIST

Sl. No.	Name of Article	Quantity	
		Essential	Desirable
Cooking Section			
1	Scales & standard weights	5	1
2	Cook's measure	4	2
3	Oven (Kerosene)	5	..
4	Spatulas (karchhi)—steel	5	5
5	Biscuit cutters	6	..
6	Kerosene stoves (non-pressure)	10	2
7	Degchis with lid (various sizes)	15	15
8	Meat knives	5	5
9	Graters	5	5
10	Cutting knives	10	10
11	Karahi (iron)	10	5
12	Tongs with curved ends	5	5
13	Chakla belan	5	5
14	Tawas	5	5
15	Frying pans	5	5
16	Tong (chimta)	5	5
17	Frying spoons (flat)—steel (with holes & wooden handles)	5	5
18	Khurpis (steel)	5	5
19	Glass tumblers	12	12
20	Stirring spoons (steel) with wooden handles	5	5
21	Cutlery : (steel)		
	Knives	8	8
	Forks	8	8
	Serving spoons	12	6
	Desert spoons	6	6
	Tea spoons	6	6
22	Tea sets for 2	4	1
23	Tea strainers (steel)	6	1
24	Tea trays	5	5
25	Oven trays	5	1
26	Tray cloths	12	..
27	Tea cosy	4	1
28	Wooden spoons	5	5
29	Eggbeaters (steel)	5	1
30	Dahi beaters (wooden)	5	..
31	Grinding stones (sil & batta)	5	..
32	Grinding stones (Pestle-mortar or kundi-sota)	5	..
33	Grinding machines	2	..

Sl. No.	Name of Article	Quantity	
		Essential	Desirable
34	Sieves (soup)	5	1
35	Thals (brass or stainless steel)	5	1
36	Enamel plates	5	5
37	Enamel bow 30 cm (12) diam	10	2
38	Katories	15	5
39	Mugs (Aluminium)	10	..
40	Iron container for coal (for 40 Kg. coal)	1	..
41	Glass measuring jar (1/2 litre)	5	..
42	Jharan	48	..
43	Floor dusters	12	..
44	Containers for provisions :		
	5 Kg. capacity	12	..
	1 Kg. capacity	12	..
45	Jelly moulds (medium)	12	1
46	Wire toaster	5	1
47	Baking tins (1/2 Kg.)	5	1
48	Food tongs	5	1
49	Full plates	8	4
50	Quarter plates	8	4
51	Half plates	8	4
52	Soup plates	8	4
53	Chutney dishes (small)	5	1
54	Salad bowls	5	1
55	Salad plates (large size for mixed salads)	5	1
56	Serving bowls (China)	15	1
57	Steel wool	24	..
58	Tomato slicer	5	1
59	Measuring spoons—set (plastic)	5	1
60	Bread knife	5	1
61	Aluminium kettle	5	1
62	Salt/pepper cellar	5	1
63	Sandwich toaster	5	1
64	Table mat	25	..
65	Sauce pan, with rounded handle	5	1
66	Tin cutter	5	1
67	Angithi	5	1
68	Table cloth]	5	1
<i>Laundry Section</i>			
69	Galvanized cylindrical boiler for laundry	1	..
70	Ironing boards	5	1
71	Ironing board covers	5	1
72	Iron : electric	5	1
	Iron : coal	5	1

Sl. No.	Name of Article	Quantity	
		Essential	Desirable
73	Jug, enamelled	10	2
74	Soap dish	5	1
75	String : clothes line	2	1
76	Clips, wooden	150	..
77	Hand towel	12	..
78	Sleeve board	5	1
79	Scrubbing board	5	1
80	Tub, galvanized iron	5	1
81	Enamel bowl (small)	10	2
82	Set of 24 test tubes in stand and a spirit lamp	1	..
83	Blanket	5	1
84	Jars and bottles—assorted set of 6	5	1
85	Wooden hanger	24	..
<i>Home Nursing Section</i>			
86	Splints—set of various sizes	5	1
87	Triangular bandage	20	4
88	Roller bandages—various sizes	24	..
89	Clinical thermometer	5	1
90	Ounce glass 113 gm.	5	1
91	Enema can—set with rubber tubing and nozzles	1	..
92	Air cushion	1	..
93	Ring cushion	1	..
94	Iron bed	1	..
95	Mattress	1	..
96	Pillow	4	1
97	Pillow cover	8	..
98	Bed sheet	8	..
99	Draw sheet	8	..
100	Bed cover	2	..
101	Blanket	1	..
102	Hot water bottle	1	..
103	Ice bag	1	..
104	Feeding cup	1	..
105	Mackintosh	1	..
106	Mosquito net	1	..
107	Doll—rubber or plastic to act as dummy	1	..
<i>Housewifery Section</i>			
108	Bottles and jars—set of three	5	1
109	Bucket (15 to 20 litres capacity)	5	1
110	Brooms with handles of different type	5	1
111	Jharan	12	..

Sl. No.	Name of Article	Quantity	
		Essential	Desirable
112	Dust tray, with handle	5	1
113	Dust bin with lid and foot lever	1	..
114	Scrubbing brush	5	1
115	Flower vase	5	1
116	Stem holder	5	1
117	Set of tools : hammer, screw driver, pliers, nail puller	1	..
<i>Needle Work Section</i>			
118	Tailor's scissors	5	1
119	Measuring tape (Tailor's type)	5	1
120	Ruler, full size (Tailor's L—pattern with curve on one side)	5	1
121	Metre ruler	10	..
122	Thread and needles (assorted set)	5	1
123	Thimble	20	..
124	Sewing machine (Hand)	3	..
125	Sewing machine (Foot)	2	..
126	Skirt board	2	..
127	Electric iron	2	..
<i>Furniture and Fittings</i>			
128	Work table with tin sheeted top (90×150×90 cm. high) (3'×5'×3')	6	..
129	Stool 60 cm. (2 ft) high	20	..
130	Teacher's chair	1	..
131	Steel almirah	1	..
132	Long cutting table (180×90×82 cm.) (6'×3'×2 ½')	2	..
133	Ingredients table (150×90×82 cm.) (5'×3'×2 ½')	1	..
134	Wash basin	10	2
135	Show case	1	1
136	Notice board	1	..
137	Towel rack	6	..
138	Folding screen	1	..
139	Full size mirror	1	..
140	First aid box	1	..

SUPPLEMENTARY LIST

Sl. No.	Name of Article	Quantity
1	Electric oven	1
2	Ice box	1
3	Electric kettle	2
4	Pressure cooker	2
5	Electric hot plate	2
6	Coffee percolator	1
7	Driplator—coffee type	6
8	Icing set	2
9	Coffee set for 2	5
10	Coffee spoon	12
11	Double boiler	6
12	Electric toaster	2
13	Steaming basket	5
14	Steam pudding basket	1
15	Steam cooker	1
16	Bread cutting machine	1
17	Student's microscope	1
18	Electric Geyser—20-gallon capacity	1
<i>Audio-visual Aids</i>		
19	Slide and strips projector	1
20	Charts and models on domestic science—set	1
21	Articulated skeleton with show case	1

मन्त्रमैत्र नयनं